

A REVIEW OF THE GENERA OF THE FAMILY MYTILIDÆ.

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THE shells of the genus *Mytilus* have not been favourites among conchologists, because few of them display any elegance of shape or any beauty of colour. Their dentition has been dismissed as variable, the so-called cardinal teeth being described as small or obsolete, and the crenulations, which often occur on the anterior border and sometimes on the dorsal border, have not been regarded as true teeth.

The recent researches of M. Félix Bernard¹ into the development of their hinge-teeth have, however, invested the Mytilidæ with a much greater interest for all those who concern themselves with the phylogenetic classification of the Pelecypoda and with their palæontological history.

The observations of Neumayer and Bernard have shown that in some genera of Lamellibranchs the embryonic shell (prodissoconch) does not show any crenulations along the hinge-line (e.g. *Cytherea*, *Lucina*, etc.); while in others this hinge-line is slightly thickened and crenulated, forming a slender and primitive hinge-plate, which Dr. Dall has called the *provinculum*. In the centre of this provinculum there is a small ligamental pit separating the crenulated band into two series, an anterior and a posterior.

The crenulations of the provinculum seldom persist into the adult stage, other teeth being subsequently developed which take their place, and a more solid hinge-plate being formed in connection with these later teeth. These secondary teeth are known as dysodont teeth in the Mytilidæ and as taxodont teeth in the Arcidæ and their allies, but Bernard has shown that both kinds have the same origin, and that they spring from the terminations of internal ribs.

Bernard remarks that the study of the hinge-teeth should commence with the Mytilidæ, because the genera of this family "furnish the key of all the problems which present themselves in this period of their evolution. It is, in fact, in this family that the development [of the hinge] is slowest, and consequently the plainest, the stages being clearly separated from one another; in it, also, the dental products exhibit a primitive character and a minimum of differentiation,

¹ "Notes sur le développement et la morphologie de la coquille chez les Lamellibranches": Bull. Soc. Géol. Fr., 1895 and 1896, vols. xxiii, xxiv. "Sur le développement des dents de la charnière chez les Lamellibranches": C.R. Acad. Sci. Paris, 1897, vol. cxxiv, p. 1165. "Recherches sur la coquille des Lamellibranches": Ann. des Sci. Nat., 1898, vol. viii, pp. 1-208, pls. i-xii.

without any possibility of these facts being attributable to retrogression."¹

Further, he observes that the Mytilidæ are remarkable for the important part taken by the provinculum, and for the manner in which the permanent ligament is developed. At the close of the embryonic stage there is in this, as in all the allied families, a sudden change in the growth of the shell, a *dissoconch* being formed, which is gradually enlarged into the adult shell. In this process Jackson has recognised two transitory stages, which he has called the *nepionic* and the *nealagic*. In the Mytilidæ that which becomes the permanent ligament is developed separately in the nepionic stage, a second small ligamental pit appearing on the hinge-line or provinculum, behind the central ligament-pit of the prodissoconch.

From the time when this second ligamental pit makes its appearance, the crenulations on the posterior part of the provinculum are greatly modified; those which lie between the two ligamental pits become pinched up, while those behind the second pit increase in number, and the ligament extends itself posteriorly below the crenulations as the provinculum grows and extends in that direction.

With the commencement of the succeeding Nealagic stage, the growth of the crenulated band or plate is stopped, and teeth of another kind begin to form at each end of it. These are traceable to the primitive riblets of the shell, and for them Bernard adopts Neumayer's name of *dysodont* teeth. The hinge-line is thus continued and extended by a series of dysodont teeth, and, at the same time, the posterior ligament increases in length until it passes beyond the limit of the provinculum and reaches the posterior dysodont teeth, sometimes remaining below these teeth, as in *Crenella*, but generally spreading upward, and erasing all the provincular teeth and sometimes all of the dysodont teeth as well.

On the anterior side of the shell other changes are in progress during this Nealagic stage. This side is bent gradually inward, or, as Bernard expresses it, rotated on an axis, so that it encroaches more and more on the anterior part of the primitive crenulated hinge-plate. This process is continued till, in *Mytilus*, all the anterior part of the original crenulated band is obliterated by the incurved border with its dysodont teeth, the earlier dysodont teeth being thus brought beneath the umbo, while later teeth appear on the border below and in front of it.

The final result in a typical *Mytilus* is that the primitive central ligament-pit is obliterated by the incurvature of the anterior border, and the posterior teeth are generally obliterated by the growth and extension of the permanent posterior ligament, so that in most cases the hinge consists entirely of the anterior dysodont teeth, a few of which generally persist beneath the umbones of the adult. Sometimes, however, even these disappear as separate teeth, and the hinge becomes almost edentulous.

¹ Ann. des Sci. Nat., Zool., tom. viii, p. 67 (1898).

There are, however, many exceptions to this obliteration of the posterior denticulations; in one group of shells (hitherto included in the genus *Mytilus*) all these posterior teeth persist in the adult, the ligament remaining entirely internal; in others many of the dysodont teeth are effaced by the upward growth of the ligament, but some still remain beyond its termination.

M. exustus (Linn.) is a species in which all the posterior teeth thus persist. The hinge of a young specimen of this species was figured by Bernard, but he does not seem to have been aware that the stage which he figures persists in the adult. He makes it clear, however, that these posterior crenulations are of exactly the same nature as the anterior denticles, the position of the latter below the hinge and umbo being due entirely to the incurvature of the shell during the dissoconch stage.

It would appear, therefore, that Bernard's work makes it necessary for conchologists to reconsider the generic values of the characters presented by the shells of the Mytilidæ, and to revise the genera and subgenera, so as to establish these groups on a sounder and more satisfactory basis.

In the first place it seems to me that those species of *Mytilus* which possess posterior denticulations on the hinge-line of the adult shell should be separated from the species which do not present this character, and should be grouped in a distinct genus. There is a better reason for such separation than at present exists for separating *Mytilus* from *Modiola*, for a typical *Modiola* differs from an edentulous *Mytilus* only by a less amount of rotation and incurvature of its anterior side, whereas a denticulate *Mytilus* retains an important embryonic character of the hinge-line; and it is generally admitted that a hinge-character is of more importance than one which merely affects the shape of the shell.

Again, there are some species, at present included in the genus *Modiola*, which possess a similar row of posterior denticulations. Of this group *Modiola citrina* (Chemn.) is the type, and if this be compared with *Mytilus exustus* and *M. Domingensis* it will, I think, be apparent to everyone that there is a much closer resemblance between all three than there is between *Modiola citrina* and *Modiola modiolus*. There are many species of *Mytilus* in which the umbones are by no means terminal, and some of these have sometimes been referred to *Mytilus* and sometimes to *Modiola*.

The union of the two groups typified by *M. citrinus* and *M. Domingensis* has been advocated by Dr. H. von Ihering, and on this point I quite agree with him, only I lay more stress on the denticulation of the hinge-line than he does, and less on the surface-structure of the shell. I would therefore raise the assemblage to the rank of a genus, and should include in it the group for which the name *Mytilaster* was proposed by the Marquis de Monterosato in 1884.

In this connection I would remark that the sculpture of the external surface of the shell does not seem to be a character of much importance in the Mytilidæ. If it were always correlated with other differential characters it might be so regarded, but this is not the

case. The true *Mytilus* is generally smooth, but there are a few striated and ribbed species which can hardly be excluded from the genus. In the case of *Modiola*, even when all the species which have a denticulate hinge are removed, there still remains at least one species, *M. demissus*, better known as *M. plicatula*, which is a true edentulous *Modiola*, and yet is strongly ribbed. Lastly, in the *Mytilaster* group, there is every gradation from a smooth shell to divaricate striation.

In studying the shells of Mytilidæ, therefore, the position of the umbones and the surface sculpturing of the shell may be regarded as features of secondary importance. If, on the other hand, we look to the characters of the hinge, and to the number and position of the muscular impressions, we shall find that these afford a much more satisfactory means of distinguishing genera and subgenera from one another.

I have studied the hinge of a considerable number of species of *Mytilus*, and have found that, though in some species the number of teeth varies, yet it does so within narrow limits, while in other species there is little or no variation. Further, I find that there are few, if any, species of *Mytilus* which are really edentulous, and that the dental characters are more or less correlated with the other special characters which have been mentioned, so that the teeth are really as useful a basis for diagnosis as they are in any other family.

In the common *Mytilus edulis*, and in all the closely allied species, such as *Galloprovincialis*, *borealis*, *Dunkeri*, *latissimus*, and *planulatus*, the teeth are connected with a series of small riblets on the anterior side of the shell. These riblets descend from the extreme border of the shell, which is incurved against the hinge-line beneath the umbo; this border is thickened so as to form a kind of hinge-plate, and the teeth arise from the plate opposite the grooves which separate the riblets. All these details can be clearly seen on any half-grown British *M. edulis* from 37 to 50 millimetres long ($1\frac{1}{2}$ to 2 inches). The position of the teeth thus accords with the origin attributed to them by Bernard; they represent the ends of the primitive internal ribs, corresponding with the grooves or depressions between the external ribs, which were developed in the neallogic stage of the shell. There is no trace of such riblets on the posterior side even of very young shells, and, if teeth were ever formed on this side of the hinge, they have all been obliterated by the elongation and upward growth of the ligament.

The number of these anterior teeth in this group of shells varies even in the same species. In *M. edulis* it varies from 3 to 6 in each valve, but so far as my experience goes 4 is the usual number, and, when 6 occur, three of them are generally very small, and are placed close together, so that they only occupy the space of two in a more normal specimen. In *M. Galloprovincialis* the normal number appears to be 3, though occasionally there are as many as 5. In what I take to be *M. unguatus*, of which I have seen specimens from the Falkland Islands and from Vancouver, the number of teeth varies from 2 to 4 or 5, and seems largely to depend on the extent to which the anterior side is inflexed beneath the umbo, the degree of inflexion

varying greatly in this species. In *M. Dunkeri* and *M. crassitesta* (both from Japan) this inflexion is extreme, the umbones are terminal, and the teeth of the adult shell are reduced to 2 in each valve.

In the group typified by *M. afer*, *M. perna*, *M. smaragdinus*, and *M. latus*, the anterior side is always more inflexed than in *M. edulis* and *M. Galloprovincialis*; the riblets are fewer, and the teeth are never more than 2 in number, frequently appearing as 2 in one valve and 1 in the other. The two teeth do not always occur in the same valve, some species having them in the left (*M. smaragdinus*), others in the right valve (*M. latus* and *M. perna*). The single tooth of one valve always fits into the space between the two of the other valve. The final stage of the suppression of these anterior teeth seems to be reached in *M. Magellanicus*, *M. crenatus*, and their allies. In these species the anterior margin is so inflexed and twisted under the hinge-line that the teeth of one valve seem to have been compressed into a single tooth or ridge which fits into a hollow or groove in the other valve, the teeth of the latter having become entirely obsolete. In these species the umbones are more than terminal, for in most cases they project beyond the anterior side.

To sum up, therefore, out of those species of the genus *Mytilus* which do not possess denticulations behind the ligament, three groups can be based on the differences of the anterior teeth. In the first group the umbones are seldom terminal, there being generally a small anterior inflation which bears from 2 to 6 small teeth. In the second group the umbones are terminal, the dental area is compressed, and there are never more than 2 teeth, generally 1 opposed to 2. In the third the umbones project beyond the anterior side, and the dental formula is 1 opposed to 0.

Passing now to the differences in the number and position of the adductor and retractor scars, we find that they are important, because they are correlated with other differences both in the shell and in the animal. So far as I can ascertain, the first detailed account of the anatomy of a mussel of the *M. latus* type was that by Mr. A. Purdie, published in 1887 by the New Zealand Government as one of the Studies in Biology at the Colonial Museum.

Mr. Purdie compared the anatomy of *M. latus*, *M. edulis*, and *M. Magellanicus* from New Zealand material, and the following are his conclusions:—"While *M. edulis* and *M. Magellanicus* agree so closely as to leave no question of their being members of one genus, there is a very considerable interval between them and *M. latus*. To pronounce definitely upon the above question [are *M. latus* and *edulis* congeneric?] would require an intimate knowledge of a great number of species of Mytilinæ, when it is possible that all intermediate stages between the above distinct forms might be found. My study of the internal structure has extended only to the three species mentioned in this paper, but so far as this serves to decide, there seems to be occasion for separating *M. latus* from the others, if not as a genus, at any rate as a subgenus." He gives a complete tabular view of the differences between *M. latus* and *M. edulis*, of which the following are the most important:—

M. edulis.

Muscles.—Anterior adductor present.
 Anterior retractor attached to the foot.
 Posterior retractors of the byssus united in one bundle.
Cavité des flancs.—Of considerable size.
Plaited organs.—Large.
Circulatory system.—Arterial system double and equilateral.
 Mantle supplied from anterior aorta; posterior aorta small.
 Marginal artery absent.
 Oblique vein anterior to the combined posterior retractors.
Organi of Bojanus.—Communicates with the pericardium by a large passage.
Gills.—Ascending lamellæ quite free at their upper edge.
Mantle-lobes.—Broadly joined at the posterior end.

M. latus.

No anterior adductor.
 Anterior retractor attached to byssus.
 Posterior retractors of the byssus separated into two portions.
 No trace of such a cavity.
 Rudimentary.
 Arterial system single and median.
 Mantle in part supplied from posterior aorta, which is large.
 Marginal artery present.
 Oblique vein between middle and posterior retractors.
 Has no communication with the pericardium.
 Ascending lamellæ attached by their upper edge.
 Lobes joined only by a short transverse bar.

The differences in the arrangement of the muscles are, naturally, indicated on the shell; that of *M. latus* showing the scars of three retractor muscles, a small anterior one below the ligament, a large rounded middle one, and a posterior scar united to that of the posterior adductor. There is, of course, no anterior adductor scar, so that, in respect of adductor muscles, the mollusc is monomyarian, not dimyarian.

In *M. edulis*, on the other hand, there is a small but well-marked anterior adductor and an anterior retractor, while the scars of the middle and posterior retractors are united to one another and to the posterior adductor, the combination forming a scar which has somewhat the shape of the figure 6.

Now there are many species which present the same arrangement of muscular scars as in *M. latus*; they include *M. afer*, *M. variegatus*, *M. perna*, and *M. smaragdinus*, and they are the same group which has been separated by the 2-1 arrangement of teeth mentioned on p. 215. Presumably, therefore, the anatomical structure of these species is more or less similar to that of *M. latus*. It is, however, very desirable that other species should be examined, in order to determine this, for the relative distance between the scars of the middle and posterior retractors differs in different species, and some of them (as Mr. Purdie has suggested) may be intermediate in structure between *M. latus* and *M. edulis*. It is, in fact, stated by Dr. von Ihering, that, in the case of *M. chorus*, the separation of the retractors is sometimes incomplete, "and then the impression of the [central] byssal muscle is contiguous to the rest of the posterior retractor scar."¹ *M. meridionalis* seems also to be a connecting link in this and other respects between the two groups.

Dr. H. von Ihering was, I believe, the first to recognise that this isolation of the middle byssal retractor and the absence of an anterior

¹ Proc. Malac. Soc., vol. iv, p. 85.

adductor were characters that marked off a certain group of species,¹ and that this assemblage included the species which had been separated by Mörch in 1853, as a subgenus of *Mytilus*, under the name of *Chloromya*.² Mörch gave no diagnosis, merely enumerating the species *perna*, Linn., *Africanus*, Chemn., *variegatus*, Chemn., *smaragdinus*, Chemn., and *latus*, Lamk. Von Ihering established the subgenus on the characters above mentioned, and made *M. perna* the type, but did not notice the teeth, which, as I have shown, are also distinctive of this group.

There is another group of *Mytilus* which is also generally monomyarian by the absence of the anterior adductor, though the arrangement of the byssal muscles is the same as in *M. edulis*. This is the strongly ribbed section typified by *M. Magellanicus*, and separated by Mörch under the name of *Aulacomya*. As von Ihering remarks, the want of an anterior adductor is not in itself a very important character, and he states that this muscle is really always present in young *M. Magellanicus*, though it disappears in older specimens.³ Nevertheless, when its loss is associated with other characters such as those of the hinge (see p. 218) and the ribbing of the shell, it becomes useful as a means of diagnosis.

From the observations above recorded we can now distinguish more clearly the several groups into which the genera *Mytilus* and *Modiola* may be divided, and shall be able to form some idea of their generic or subgeneric value.

Genus MYTILUS, Linnæus.

Umbones generally subterminal, but sometimes terminal; anterior expansion of the shell very small or obsolete. Hinge with a variable number of small teeth on the anterior side, these teeth being connected with an equal number of small short riblets which curve inwards from beneath the umbones. Outer surface of shell smooth, except in the subgenus *Aulacomya*. Anterior muscular scar small, and in some cases absent.

Subgenera.

Eumytilus, Ihering. Anterior side with a small ribbed expansion under the umbo, the margin of which bears several small teeth, generally from 3 to 5, but sometimes only 2; these teeth vary in size and number, even in the same species. Anterior adductor scar always present, the median and posterior byssal scar united to one another and to that of the posterior adductor. Type, *M. edulis*, Linn.

To this group belong the following species:—

¹ Op. cit., pp. 85, 87.

² "Catalogus Conchyliorum quæ reliquit Comes de Yoldi, Hafniæ," 1853, pt. ii, p. 52.

³ Mr. Purdie seems to have found that an anterior adductor was always present in the New Zealand form of *M. Magellanicus*. I have not been able to ascertain whether it differs in any other respects from that species.

- M. Galloprovincialis*, Lamk.
M. unguatus, Linn. (non Lamk.).
M. Grunerianus, Dunker.
M. Dunkeri, Reeve (= *Grayanus*, Dunker).
M. latissimus, Clessin.
M. planulatus, Lamk.
M. Californicus, Conrad.
M. borealis, Lamk.
M. crassitesta, Lischke.
M. Patagonicus, d'Orb.

Chloromya, Mörch. Umbones more completely terminal, and the anterior side inflexed so as to form a small hinge-plate below the umbo. Shell always smooth. Riblets of anterior side short, and sharply inflexed beneath umbo. Teeth 1-2 or 2-2; most frequently the former, but the single tooth is sometimes in the right, sometimes in the left valve. No anterior adductor scar, byssal scars three, an anterior, a median, and a posterior, the latter united to the posterior adductor. Type, *M. perna*, Linn.

To this group belong the following species:—

- M. pictus*, Born (= *M. afer*, Gmel.).
M. latus, Chemn.
M. variegatus, Chemn. (= *M. achatinus*, Lamk.).
M. smaragdinus, Chemn.
M. meridionalis, Krauss.
M. Taprobanicus, Blauf.
M. palliopunctatus, Dunker.
M. chorus, Molina.

Aulacomya, Mörch. Shell always ribbed or furrowed. Umbones terminal, elongated, and often projecting beyond and in front of the anterior side, which has only a single riblet twisted in under the umbo. Ligament long and carried in a channel beneath the umbones. Hinge without definite teeth, but having a tooth-like ridge in one valve which fits into a groove or depression in the other valve. Anterior adductor often absent, but other scars as in *Eumytilus*. Type, *M. Magellanicus*, Chemn.

The only other species that I have seen which can be included in this section are: *M. decussatus*, Lamk., *M. crenatus*, Chemn., and perhaps the rare *M. oblongus*, Clessin.

It will be convenient to consider the genus *Modiola* next, before passing on to the other species which possess posterior erenulations as well as anterior teeth. I have elsewhere¹ given my reasons for holding to the Lamarekian name of *Modiola* (or *Modiolus*), and for rejecting that of *Volsella* of Scopoli. The following will serve as a definition of the *Modiola* shell.

Genus *MODIOLA*, Lamarek.

Shell oblong or elongate, oblique, generally inflated toward the

¹ Journ. Conch., vol. xi, p. 101 (1904).

anterior side, and often compressed on the posterior side. Smooth or concentrically striated, seldom ribbed,¹ but in some species feebly striated on the posterior slope. Umbones obtuse, anterior, but seldom terminal. Anterior margin expanded in front of the umbones, but quite smooth. Hinge-line without teeth or crenulations. Anterior adductor scar larger than in *Mytilus*; posterior scars united, the byssal portion long and narrow, the adductor part rounded and not bulging upwards as in *Mytilus*.

According to Bernard the development of the hinge-line in *Modiola* differs in several respects from that of *Mytilus* (see references on p. 211). In the nepionic stage, the crenulations of the provinculum are finer and closer than in *Mytilus*; in the nealagic stage, dysodont teeth appear on the posterior extension of the hinge-line, but are long, slender, and oblique, not short and vertical as in *Mytilus*. Moreover, the extension of the ligament is more rapid than the growth of these teeth, so that it quickly covers those that are first formed, and then prevents the formation of others.

As regards the anterior side, the few dysodont teeth that are here developed are obliterated by the backward inflexion of that side, and no fresh teeth are developed on the margin below them, as in the case of *Mytilus*, so that both sides of the hinge-line remain toothless.

The development of the hinge of *Lithodomus* is in all respects similar to that of *Modiola*.

There are several shells which have been described as belonging to the genus *Mytilus* which seem to me more properly referable to *Modiola*, because they all have a smooth, toothless, expanded margin, below or in front of the umbones. One of these is the large *Mytilus tortus*, for which Gray created the subgenus *Stavelia*. It certainly will not come under any of the subgenera of *Mytilus* which I have defined above, but I cannot see that it differs in any particular from the diagnosis of *Modiola*, and it has much resemblance in form to the well-known *M. barbata* of the British coast. The peculiar twist of the anterior side does not seem to me a sufficient character for establishing a subgenus, especially as no other species with a similar twist has yet been found, so that there is no group of twisted shells. Moreover, it is generally admitted that the nearest ally of *M. tortus* is *M. horridus*, and the alliance is indeed so close that Mr. E. A. Smith informs me that the former may be regarded as a twisted form of the latter. I am glad to say also that he agrees with me in referring both species to the genus *Modiola*.

H. von Ihering, in the paper before mentioned, not only failed to recognise the true affinities of these two species, but actually grouped them with *M. hirsutus*, and made the latter the type of a new subgenus of *Mytilus* for which he proposed the name *Trichomya*. In my opinion *M. hirsutus* differs so greatly in all essential characters that it does not even belong to the same genus as the shell which should be called *Modiola torta*. It has a crenulated hinge-line, and is

¹ *M. demissus* (= *M. plicatula*, Lamk.) is a true *Modiola*, though ribbed.

consequently referable to the same group as *M. exustus*, a group which has been separated by Mörch as the subgenus *Hormomya*. I cannot therefore recognise the subgenus *Trichomya* as having any value whatever.

Other species, generally called *Mytilus*, which I would transfer to *Modiola* are: *M. confusus*, Angas, *M. ater*, Frauenfeld, and *M. atratus*, Lischke.

With regard to the subdivisions of *Modiola*, I cannot, of course, accept the sections and subgenera adopted by Dr. Dall in 1898,¹ because he includes those with a crenulated hinge-line, like *Brachydontes* and *Gregariella*, which I transfer to another genus.

A few species of *Modiola* have smooth, polished shells, and these have been grouped under the name *Amygdalum*; it may be convenient to recognise this group as a natural section of the general assemblage, but the character on which it is based does not seem to me of much importance. There are other forms, such as *M. auriculata*, Krauss, *M. linea*, Reeve, and *M. flavida*, Dunker, which differ from the type and from one another, and may be separable as subgenera, but the whole assemblage of toothless Mytilidæ requires further investigation, not only as regards the shells, but the animals themselves.

Myrina has been placed by Fischer as a subgenus of *Modiola*, and may perhaps be so retained, for though its course of hinge-development, as described by Bernard, is slightly different, it practically becomes a *Modiola* when adult. *Adula* is another group which may be placed here, but is certainly a link between *Modiola* and *Lithodomus*.

Lithodomus itself next claims attention, and if I were classifying the Mytilidæ for the first time, I should not think it worthy of generic separation, but should regard it as a subgeneric group, obviously derived from *Modiola*, and modified only in consequence of having taken to excavating holes in hard substances. The longer siphons of the animal and the cylindrical form of the shell are the most obvious points in which *Lithodomus* differs from *Modiola*; and in *Botula*, as well as *Adula*, there are certainly connecting links.

I find, however, from a perusal of Dr. Th. List's excellent monograph² of the Mediterranean *L. lithophagus* that the muscular system does differ to some extent from that of *Modiola*. The anterior adductor is relatively stronger, and the posterior smaller, so that the two adductor scars are nearly equal in size; the posterior retractor byssi forms a small oval scar directly above the adductor, and there is no separate pedal scar, the muscle being rudimentary, and its terminal surface united with that of the retractor byssi. Thus the shells which retain a definite anterior expansion of the shell, with a smooth interior margin, and present a hinge-line entirely destitute of teeth or crenulations, may be grouped in the two genera *Modiola* and *Lithodomus*. Their sections and subgenera may be tabulated as below.

¹ Trans. Wagner Free Inst. Sci. Philadelphia, vol. iii, pt. 4, p. 791.

² "Fauna und Flora des Golfes von Neapel": Zool. Stat. zu Neapel, Mon. 27, Die Mytiliden, von Dr. Th. List, 1902.

Genus *MODIOLA*, Lamk.

Section *Eumodiola* (von Ihering). Shell obliquely oblong, more or less expanded on the posterior side, and inflated along a central oblique line from the umbo to the posterior side of the ventral border. Ex. *M. modiolus*, (Linn.).

Section *Amygdalum* (Megerle). Shell elongate, narrow, not inflated, smooth, and polished. Ex. *M. arborescens*, (Chemn.).

Subgenus *Adula* (H. & A. Adams). Shell elongate, transverse, straight, and subcylindrical; umbones between centre and the anterior end. Ex. *A. soleniformis*, (d'Orb.).

Subgenus *Myrina* (H. & A. Adams). Shell oblong, transverse, not oblique, and nearly equilateral. Ex. *M. pelagica*, (Forbes).

Genus *LITHODOMUS*, Cuvier.

Shell long, narrow, and subcylindrical. Umbones at or near the anterior end, which is rounded and inflated. Posterior end generally wedge-shaped, but sometimes cylindrical and tapering. Shell surface smooth or wrinkled. Hinge-line straight, without crenulations. Margins of shell quite smooth. Adductor scars oval and nearly equal; byssal scars oval and small. Ex. *L. lithophagus*, (Linn.).

Subgenus *Botula* (Mörch). Shell oblong, subrhomboid, umbones terminal, prominent, and spirally curved. Ex. *B. cinnamomea*, (Lamk.).

We now come to the species which possess denticles or crenulations on the hinge-line *behind* the ligament, and these I propose to group in a separate genus, because I regard this character of generic importance, and of much greater value than the relative position of the umbones, which has hitherto been regarded as the only real distinction between *Mytilus* and *Modiola*.

I agree with von Ihering in grouping together the shells with subterminal umbones, which Mörch made a subgenus of *Mytilus*, under the name of *Hormomya*, and the shells for which Swainson proposed the name of '*Brachidontes*,' generally regarded as a subgenus of *Modiola*; but I cannot follow him in transferring the typical species of *Brachidontes* to *Hormomya*, and in retaining the former name for *Modiola demissa*.

The name '*Brachidontes*' (Swainson, 1840) has priority over that of *Hormomya* (Mörch, 1853), and Swainson's type is *Modiola sulcata*, Lamk.; hence Swainson's name, or some amended form of it, must be taken as the name of the new genus, though *Hormomya* can be used as a subgeneric name for the striated mytiloid forms like *M. exustus*, Linn., and *M. Domingensis*, Lamk. From these latter the little group for which the Marquis di Monterosato proposed the name *Mytilaster* in 1884, differs only in the character of the external markings, but it may be convenient to retain his name and to regard the assemblage as a second subgenus.

The construction of the name *Brachidontes* is obviously very bad; one supposes that Swainson meant to convey the meaning of short teeth; and Fischer altered it to *Brachydontes*, but that is little better,

for the σ of $\delta\delta\sigma\tau\epsilon\varsigma$ cannot be omitted, and if emendation of any kind is permitted, the name must be converted into *Brachyodontes*. Personally I should like to replace it by *Brachyodon*, which would more correctly convey the meaning of a 'short-toothed shell,' but as the plural form has been allowed to stand in *Macrodon*tes and *Polydon*tes (properly *Polyodontes*) I do not alter it in this case.

There is another small group of mytiloid shells which differ very little from those which form the subgenus *Hormomya*, but has been regarded by some authors as having generic rank. This is the *Septifer* group, in which the anterior adductor muscle is attached to a myophoric plate instead of to the inner surface of the shell. In all other respects, so far as I can learn, both shell and animal agree with *Hormomya*, and the existence of a myophoric septum does not seem of sufficient structural importance to form the basis of a separate genus.

It is true that most species of *Septifer* are stout, strongly ribbed shells, but in these respects they resemble *B. (H.) hirsutus* and *B. purpuratus*; they also compare with these species in the length and strength of the ligament, and in the small number of posterior crenulations on the hinge-line, which have been left unobliterated by its extension. It seems natural, therefore, to place *Septifer* as a subgenus under *Brachyodontes*. All the species with a crenulated hinge-line will come under these four groups except *M. hamatus* (Say), which is exceptional and interesting in several particulars. In the first place, the ligament is very long, is completely marginal, and seems to have almost obliterated all the posterior crenulations of the hinge-line, for, though the shell-margin is crenulated by the ribs, these crenulations become oblique and faint near the ligament, instead of becoming stronger and transverse. It is a fact, however, that this is sometimes the case with that variable species *Brach. purpuratus*, Lamk., and its var. *oralis*. *M. hamatus*, however, has other peculiarities: there is no anterior adductor, and the united posterior byssal and adductor muscles leave a scar of unusual shape, the adductor end of which is little broader than the byssal end.

As all these peculiarities are not combined in any other species with which I am acquainted, I consider that *M. hamatus* stands by itself, and should form a separate subgenus of *Brachyodontes*, for which I propose the name of *Ischadium*, thinking that in shape and colour the shell has a sufficient resemblance to a 'dried fig' to justify the appellation.

The genus and subgenera can then be defined as follows:—

Genus BRACHYDONTES, Swainson.

Shell generally finely ribbed, but sometimes wrinkled, or even smooth. Anterior development of the shell, and consequently the position of the umbones, variable. Hinge-line generally straight, and terminating in an angle posteriorly. Ligament rather short, marginal or infra-marginal. Anterior margin with several close-set teeth; posterior border crenulated, sometimes throughout its length, above and behind the ligament, sometimes only behind the ligament.

Muscular scars similar to those of *Eumytilus* or *Modiola*. Type, *C. sulcatus*, Lamk. (= *citrinus*, Chemn.).¹

Subgenera.

Hormomya (Mörch). Shell finely ribbed; umbones subterminal; anterior side straight or incurved. Type, *B. (Hormomya) exustus*, (Linn.).

Mytilaster, Monterosato. Shell mytiloid, with nearly terminal umbones, either with a superficially crinkled surface or marked only by concentric lines of growth. Type, *M. lineatus*, (Gmelin).

Septifer, Récluz. Shell similar to that of *Hormomya*, except that the anterior adductor is fixed to a plate which forms a triangular septum at the anterior end of each valve. Type, *S. bilocularis*, (Linn.).

Ischadium, subgen. nov. Shell oblong or pyriform in outline, sculptured all over with strong raised divaricating ribs. Umbones slightly divergent; anterior riblets well-marked, and corresponding with a variable number of dysodont teeth. Ligament long, without crenulations behind it. Anterior adductor scar absent, and anterior byssal scar small. Posterior byssal scar large and broadly united to that of the posterior adductor. Type, *I. hamatum* (Say).

It may be useful to enumerate some of the species which may be referred to each of the first four groups. To *Brachyodontes*, s.s., the following are referable:—

<i>B. sulcatus</i> , Lamk.	<i>B. ustulatus</i> , Lamk.
<i>B. Menkeanus</i> , Reeve.	<i>B. Capensis</i> , Krauss.
<i>B. purpuratus</i> , Lamk.,	<i>B. striatulus</i> , Hanley.
and ? var. <i>ovalis</i> , Lamk.	<i>B. Senhausi</i> , Reeve.

To *Hormomya* the following species are referable:—

<i>B. (H.) hirsutus</i> , Lamk.	<i>B. (H.) subramosus</i> , Hanley.
<i>B. (H.) exustus</i> , Linn.	<i>B. (H.) rostratus</i> , Dkr. (in Rve.).
<i>B. (H.) Domingensis</i> , Lamk.	<i>B. (H.) tenuistriatus</i> , Dkr. (Rve.).
<i>B. (H.) cubitus</i> , Say.	<i>B. (H.) curvatus</i> , Dkr.
<i>B. (H.) Adamsianus</i> , Dunker.	<i>B. (H.) granulatus</i> , Hanley.
<i>B. (H.) Lavalleanus</i> , d'Orb.	<i>B. (H.) crebristriatus</i> , Say.
<i>B. (H.) Darwinianus</i> , d'Orb.	<i>B. (H.) Charpentieri</i> , Dkr.

To *Mytilaster* the following species belong:—

<i>M. lineatus</i> , Gmel.	<i>M. hybridus</i> , Monterosato.
<i>M. minimus</i> , Poli.	<i>M. Marioni</i> , Locard.
<i>M. crispus</i> , Cantr.	<i>M. Solisianus</i> , d'Orb.
<i>M. lacustris</i> , Costa.	(= ? <i>M. exiguus</i> , Dkr.).

Genus MODIOLARIA, Beck.

I have not paid any special attention to the genus *Modiolaria*, which is in many respects very similar to *Modiola*, but the animal

¹ It is a question whether this species will not now have to be called *Brachyodontes modiolus*, as it is certainly the *Arca modiolus* of Linnæus (1767).

has a long anal siphon and a long vermiform foot. As regards the shell, I do not consider the surface sculpturing to be of much importance, but the hinge-line is almost always crenulated behind the ligament. From Dr. List's monograph, above quoted, we learn that the arrangement of the muscles in *Modiolaria* is very different from those of other genera. In *M. marmorata* the posterior adductor is much smaller than the anterior; the byssal retractors consist of three separate muscles, viz., anterior and posterior retractors of small size and a middle group of muscle-cords which are inserted high up, below the ligament in an uninterrupted line. This division into a median byssal retractor recalls that in *Chloromya*, but the scar is very different in shape.

Modiolaria therefore may well retain the generic rank which has been given it. I think Fischer was right in placing *Gregariella* under it as a subgenus. The shell originally described as *Modiola opifex* is also a *Modiolaria*; for this shell Dr. Dall proposed the subgenus *Botulina*, but he has since admitted that this is a synonym of *Gregariella*, so that *opifex* may be included with *G. Petagnæ*.

Rhomboidella. Monterosato, 1884, only differs from *Modiolaria* in being striated all over, and cannot rank as more than a subgenus.

Other recognised genera of Mytilidæ are:—*Idas*, Jeffreys, *Dacrydium*, Torell, and *Crenella*, Brown.

In conclusion, I desire to tender my sincere thanks to all those who have assisted me by imparting information or by the loan of specimens, viz., to Messrs. R. H. Burne, J. E. Cooper, A. Hartley, Rev. A. H. Cooke, Dr. W. E. Hoyle, Mr. J. C. Melvill, Mr. J. MacAndrew, and Mr. E. A. Smith.
